



Municipal Solid Waste Management in Skardu: Current Status, and Corrective Measures

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Abstract: Solid waste management (SWM) is a marginalized sector in Gilgit Baltistan, causing a frightening situation, especially in the municipal area of district Skardu. The total municipal area of Skardu is about 4260 sq. km with a population of approximately 112996. In line with other government departments, the Gilgit Baltistan waste management company (GBWMC) is responsible for collecting and dumping solid waste. The current study was devised to calculate, characterize, and analyze the past status, and current position of municipal solid waste (MSW) production, so that necessary management practices and corrective measures can be carried out more efficiently in the study area. A series of interviews of concerned persons as well as extensive field surveys were conducted. The method used by GBWMC to collect waste was: door-to-door collection, placement of waste bins, and collection from the arterial roads. Waste was collected manually in polythene bags, handcarts, and baskets. The findings revealed that approximately 45-50 tonnes of waste was generated per day in the winter and in the summer it increases to 50-55 tonnes. The average waste generation was 0.43 kg per capita per day and is increasing at a rate of 2.28 % annually. The main sources of waste were commercial and household waste contributing approximately 60 % and 40 % of the total waste production respectively. There was no scientific disposal system for the collected waste which is dumped on the dumping sites by utilizing available resources considering Environmental protection agency (EPA) regulations along the Indus River bank. Thus specific steps should be taken to develop a proper scientific disposal system of collected wastes by incorporating the experts' expertise and modern technologies.

Keywords: Solid Waste Management, Skardu, GBWMC, Household Waste, Commercial Waste

1. INTRODUCTION

The environmental problems and their consequences are increasing day by day with the population explosion. One of the major problems faced by the contemporary world is solid waste management (SWM) [1]. Solid Waste (SWs) are all such non-flowing constituents produced by households, commercial and institution formations

and discharged from their locations for example all litter and drain cleanings, street sweepings, construction waste, animal and plant waste, etc. [2]. Municipal solid waste (MSW) mostly called trash or garbage is mostly solids or semi-solids which are produced due to domestic, commercial, or institutional formations [3]. MSW consists of durable and non-durable materials such as food scraps, bottles, papers, furniture, clothing, and

various inorganic waste, however, waste products from demolition activities, and hazardous waste products from hospitals are not included in MSW [4]. Unwanted or rejected materials produced from industrial, residential, agricultural, mining, and commercial activities contaminate our environment and create environmental problems [5]. Moreover, the huge production of SW needs collection and disposal to minimize related problems [6]. In addition, changing human activities in society produces maximum quantities of waste, and its disposal is a major problem [7].

A SW hazard is one of the most concerning problems of the modern world and its proper disposal and management have remained challenging. As the intensity of problems related to SW differs with time and location specific studies need to be carried out in respective areas to find suitable management strategies. Human generates a huge amount of waste daily which are above the capability of the environment to incorporate it into the ecosystem or reduce its harmful effects on living organisms. This has been further made worse by many materials that are not replaced by environmental forces and consequently remain together in the surroundings making SW a major issue for human beings [8]. In addition, ever-changing human activities and living standards increase the generation of waste products. A sudden increase in volume and varieties of solid and hazardous waste are a result of continuous urbanization, industrialization, and economic growth, and it is a serious concern for national and local governments. These issues can be resolved through effective and sustainable management of generated waste [9]. However, if remained ignored it can create several environmental problems especially aesthetic degradation, the production of microbes, and soil, water, and air pollution in the environment [3].

The SWs generated from anthropogenic activities from individual to household, commercial to industry level have several forms that include recyclable, combustible, hazardous, compostable, and residual waste [10]. The collection, recycling, and disposal of this waste is an important concern for those stakeholders who are responsible for developmental activities, especially in the health and environment sectors. Furthermore, SWM strategies also play a significant role to reduce

the emissions of greenhouse gases (GHGs) and to recover material and energy from SWs [11].

Many developing countries like Pakistan are facing serious environmental problems. Rapid population growth due to poor family planning, high fertility, illiteracy, and reduced gross domestic production (GDP) growth have put massive pressure on the country's natural resources and have expressively enhanced environmental pollution causing a huge SW production [2]. Rapid urbanization and waste generation are directly related and it is one of the foremost problems in developing countries. In Pakistan, the migration rate is ever-increasing [12], meanwhile, resources and expertise are scarce. In addition, none of the rural and urban areas has a proper SWM system from proper collection to proper disposal. Nearly 50 % of the total waste generation passes through the process of collection to disposal. The remaining uncollected waste causes various diseases like cholera, diarrhea, typhoid, hepatitis, dysentery, etc. [13]. In addition, it also has an immense impact on soil health and can deteriorate its properties leading to food insecurity and causing a serious threat to human survival [14].

Like other major cities of Pakistan, Gilgit-Baltistan is also facing serious challenges regarding SWM. During the past several years, considerable migration happened from rural to urban areas inducing a population explosion. The population census carried out in 1998 revealed that the population of Gilgit-Baltistan was 0.884 million [15]. However, according to GBEP [16], the population was raised to 1.1 million and 14 % of the population lived in urban centers. The population growth rate in Gilgit Baltistan is 2.56 % comparing the national average which is 1.8 % with a male-to-female rate of 52:48.

Skardu City is one of the major metropolitan cities of the country where immigrants from all parts of the country tend to settle every year. The population, buildings, and houses are increasing manifold every coming year. According to GBWMC [17], the total population of district Skardu is approximately 238644 and the population of the municipal area of Skardu is approximately 112996, which comprises 16142 households, 4672 commercial units, and 424 industrial units. Every

year thousands of national as well as international tourists visit this city to see its natural beauty and enjoy the natural weather, environment, and the peaceful spring and autumn. Therefore, a better and improved system of both the municipality and waste management seems very crucial at present to combat the challenges. The main aim of the present study was to quantify, characterize and analyze the current status and corrective measures of SW generated in the municipal area of Skardu, Gilgit Baltistan, Pakistan. This study will provide a future consensus on SW and detect the threats to the natural environment by SW and uses this data for better management of SW produced in the study area.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The present study was carried out in the municipal area of district Skardu (Figure 1). Skardu is the capital of the Baltistan division and one of the major districts in Gilgit Baltistan. It is situated along the Kohistan-Ladakh terrane ($35^{\circ}17'25''N$ $75^{\circ}38'40''E$), with an elevation of approximately 2,300 meters above sea level in the Northern areas of Pakistan at the confluence of the Indus and Shigar Rivers [18,19]. Due to its immense beauty and natural resources, Skardu is well-known for national and international tourists in all seasons. It is considered a tourist hub during summer.

According to GBWMC (2021), the total population of the municipal area of Skardu is approximately 112996 [17]. The study was focused on commercial & household SW generation, composition, transportation, and dumping methodology in Skardu City.

2.2. Municipal Committee and Gilgit-Baltistan Waste Management Company

SWM is one of the major challenges for Pakistan due to the abrupt explosion of population and lack of awareness among citizens. Like other cities in Pakistan, Skardu is also facing severe challenges regarding SWM. In Gilgit-Baltistan before 2016, the waste management (WM) sector was being operated by Municipal Committee. The WM section of the Municipal Committee was supposed to collect only main road waste daily, whereas there was no proper mechanism to collect waste from Mohallas/ Sectors and streets due to the shortage of human resources and vehicles causing environmental, health, and sanitation-related problems, especially deteriorating the natural beauty of the area. To meet the needs of environmental challenges in Gilgit-Baltistan, Waste Management Company (GBWMC) was established in 2016 in Gilgit city. After a successful operation in Gilgit, it was also established in Skardu in December 2017 while in other districts it has been recently established. GBWMC has enough human resources and vehicles to provide door-to-door services at the municipal

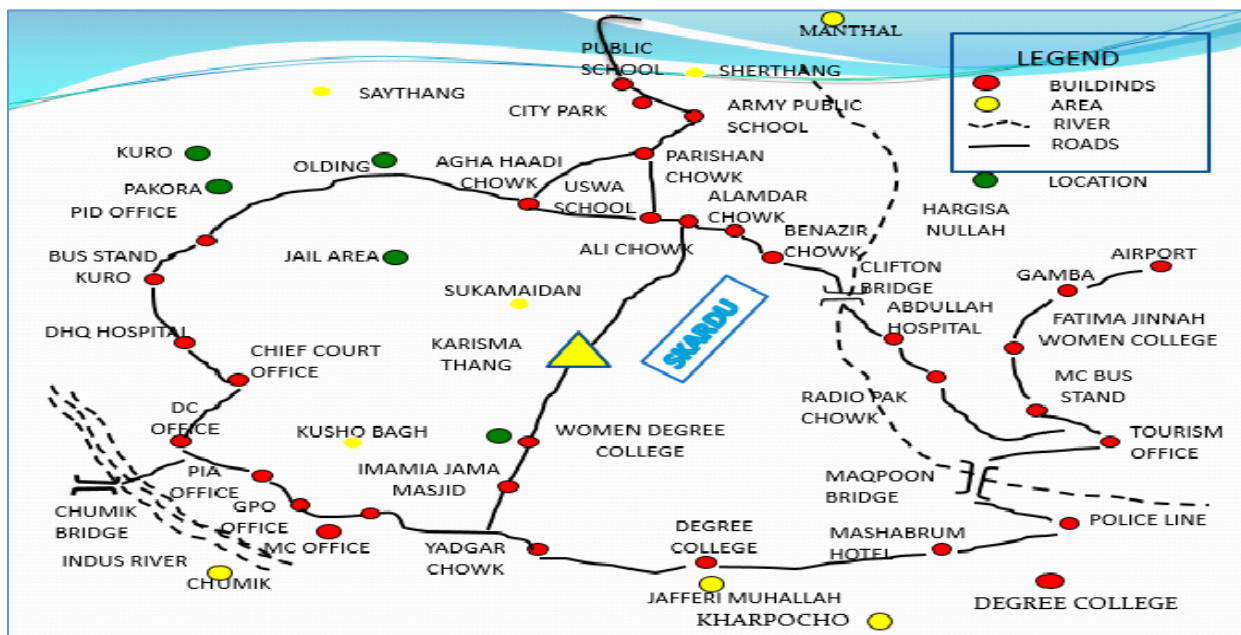


Fig. 1. Map of the Study area (Municipal area Skardu)

command area on a daily basis providing services for 24 hours (Table 1). The vehicles move from the station early morning to the destinations as well as at night for the same cause.

2.3. Research Design and Execution

The current study was based on field base observational surveys of different localities of the Skardu town area. In this study, extensive interviews were conducted with different officials from GBWMC. A series of interview sessions were also conducted with field officers, junk dealers, and scavengers to acquire data about the ratio of waste generation in the summer and winter seasons, waste quantity, waste quality, waste collection techniques, equipment used in waste collection and human resources in the GBWMC. The official data related to SWs and their management procedures were also acquired from the officials of GBWMC.

In different areas of the city field surveys on waste collection, transportation, segregation, recycling, and disposal practices were also carried out.

2.3.1. Operational Mechanism

GBWMC Skardu has the responsibility of SWM in Skardu town and is working for the collection, transportation, and dumping of SW in the town area as well as all tourist spots. To ensure the provision of efficient and well-managed sanitation services, the municipal area has been divided into 07 Sectors and Sub-Sectors based on the workload, available resources, and supervision requirements. In each sector, one supervisor, several operators, and workers have been deputed based on the population and average waste generation. GBWMC has been operating in morning, evening, and night shifts. The morning shift has the responsibility to collect the waste from Muhallas and Arterial Roads. All sectors have been operating in the morning shift. As far as the evening shift is concerned, it operates in the poultry and vegetable markets. In addition, it also responds the evening time complaints. Night shift has the mandate to clean the commercial areas through complete sweeping during the night such as waste of hotels located in commercial areas.

Table 1. Comparison of available resources and efficiency among the Municipal Committee and Gilgit-Baltistan Waste Management Company.

Resource		MC Skardu	GBWMC Skardu
Human resources	Sanitary Worker	45	58
	Sanitary Operator	09	39
	Sanitary Supervisor	03	17
	Sanitary Inspector	01	-
	District Management Officer (DMO)	-	01
Types of machinery	Trippers	-	30
	Tractors	06	09
	Dumpers	-	02
	Bucket	-	01
	Blade	-	01
	Bikes	-	15
Waste Collection	Daily	8-9 Tonnes (Approx.)	50 Tonnes (Approx.)
	Monthly	240 (Approx.)	1500 Tonnes Approx.
	Yearly	2880 Tonnes (Approx.)	18000Tonnes Approx.
Complaint Helpline	Lodged on Yearly	-	450/500
Collection Efficiency	Daily Basis	40-45 %	85-90 %

2.3.2. Transfer Station

The transfer station is a transit point for the movement of garbage to the landfill site. All the collected waste is brought to transfer stations via mini trippers. Then this waste is transferred directly into tractors and dumpers. These vehicles in turn take the garbage to the landfill site for final disposal. GBWMC has two Transfer stations currently. One is located at Ali Haider Chowk Oldling while the other one is located in the Maqponser.

2.3.3. Gilgit Baltistan Waste Management Company Skardu Organizational Structure

GBWMC has the responsibility of SWM in the municipal area of Skardu and is performing the responsibility of the collection, transportation, and dumping of SWs in the municipal area three times a day on a daily basis. The following flow diagram shows the organizational structure of the GBWMC (Figure 2).

2.3.4. Budget of Gilgit Baltistan Waste Management Company Skardu

The current annual budget of GBWMC is approximately 50 million Rupees for possible expenses including salaries of employees, and fuel charges for multi-dumper, tractor, dumper, and bikes. It also includes repairing and maintenance of vehicles and sanitary items like a mask, gloves, other admin office charges, and expenditure of awareness seminars.

2.4. Waste Collection Methods

2.4.1. Door-to-Door Collection

GBWMC provides door-to-door services in the municipal area via Mini Trippers. It has introduced a packed-waste system to manage waste. The general citizens were sensitized by the door-to-door awareness campaigns and distributed leaflets and brochures about packing waste and their social responsibilities; keeping their waste packed in plastic bags at their doorstep in the morning or waiting for the trippers. Special horns are installed on mini trippers that call the local community to bring their waste outside. Shopkeepers have wastebin/containers at their shops. In this way, waste is collected from residential and commercial areas smoothly.

2.4.2. Placement of Waste-Bin

Waste bins are placed where trippers/vehicles are not accessible. The residents of certain areas bring their waste and put it into the Wastebins in the morning and the operators clean these bins regularly.

2.4.3. Collection from Main /Arterial Roads

Workers collect waste from main roads on a daily basis by using wheel-borrows. The waste materials and garbage mostly include wrappers, papers, plastic cans, etc. However, waste from arterial roads is collected twice or thrice a week.

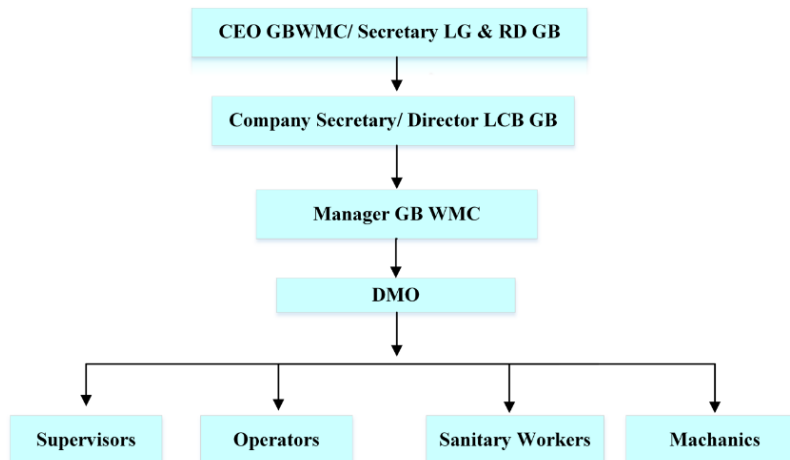


Fig. 2. Organizational structure of Gilgit Baltistan Waste Management Company Skardu

2.4.4. Manual Sweeping

GBWMC deployed 10 teams for manual sweeping in commercial areas i.e., Hussaini Chowk to Boys Degree College daily. Manual sweeping is done during the night shift in a proper uniform with health and safety gadgets by workers. Necessary tools, brooms, and waste pickers/wheel-borrow are also provided to the workers.

2.5. Waste Transportation

To transport the waste available vehicles and equipment include nine open-body tractor trolleys, thirty Trippers, two Dumper, a Bucket, and Blade. Trippers are being used to collect and dispose of waste from different sites in the town area with the help of 2-3 workers allocated to each vehicle [17]. These vehicles make 2-3 trips per working day. The collected waste is then transported to the dumping sites.

2.6. Dumping Sites

GBWMC Skardu is managing its landfill site since 2018 by burying waste. Burying waste is an easy and inexpensive method of waste management. Although, it is not a proper solution to dispose off waste in landfills however it minimizes the hazards and environmental damages like avoiding air pollution and annoying odor, etc. that is generated by the decomposition of this waste. The landfill sites are situated in the New Hussainabad area which is 5 km away from Skardu city.

3. RESULTS AND DISCUSSION

3.1. Waste Generation Overview

The volume of SW production within the municipal area of Skardu varied from season to season. During winter and autumn seasons, waste generation was usually get reduced largely as the citizens prefer to store the waste for harsh and frosty winters as well as during this season a large number of families migrate to other cities for winter which reduces waste generation. The produced waste comprised municipal/ kitchen/domestic waste, commercial waste, and other scraps, etc. The study revealed that in Skardu City, total waste generated during the winter season was approximately 45-50 tonnes

per day with a generation rate of 0.4-0.66 kg/capita/day while in the summer season, the ratio of waste production was comparatively increased due to overflow of tourists [20]. For the year 2020, the total waste collected by GBWMC [17] was approximately 13,128 tonnes. The maximum waste of approximately 1281 tonnes was collected in May and the minimum amount of waste was collected during January, which was approximately 882 tonnes.

For the year 2021, the total waste collected by GBWMC [was approximately 17782 tonnes. The maximum waste of 1640 tonnes was collected in June and the minimum waste was collected during January which was 1262 tonnes. It was observed that the trends of the waste collection varied and diverted from normal trends during the different months of the year 2020 due to the Juglot Skardu Road (JSR) blockage and fuel shortages for vehicles [21] in Skardu causing inefficient waste collection during peak season. However, the waste collection in the city during the year 2021 reflects the actual waste generation trends (Figure 3).

3.2. Nature of Generated Waste

The generated waste was composed of kitchen waste, fabrics, confectionery, snacks wrapper, rocks, spray cans, glass, polythene (shopping) bags, milk pack boxes, plastic bottles, clothes, wood pieces, slaughter and poultry waste, old tires, cutting hairs, papers, old shoes, electronic waste, medical waste, glass bottles, electrical items, blades, agricultural inputs packaging's, vegetable and fruits, etc. Similar results were obtained by Hussain et al. [22] who studied Quantification, Composition, and Disposal Methods of Municipal Solid Waste at Konodas Gilgit.

3.3. Solid Waste from Commercial Units and Household Units

According to the statistical data provided by GBWMC [17], the total population of the municipal area of Skardu is approximately 112996. Results revealed that the average waste generated in the municipal area of Skardu is approximately 50 tonnes/day, which comprises household waste and commercial waste. The average waste generation in the municipal area was approximately

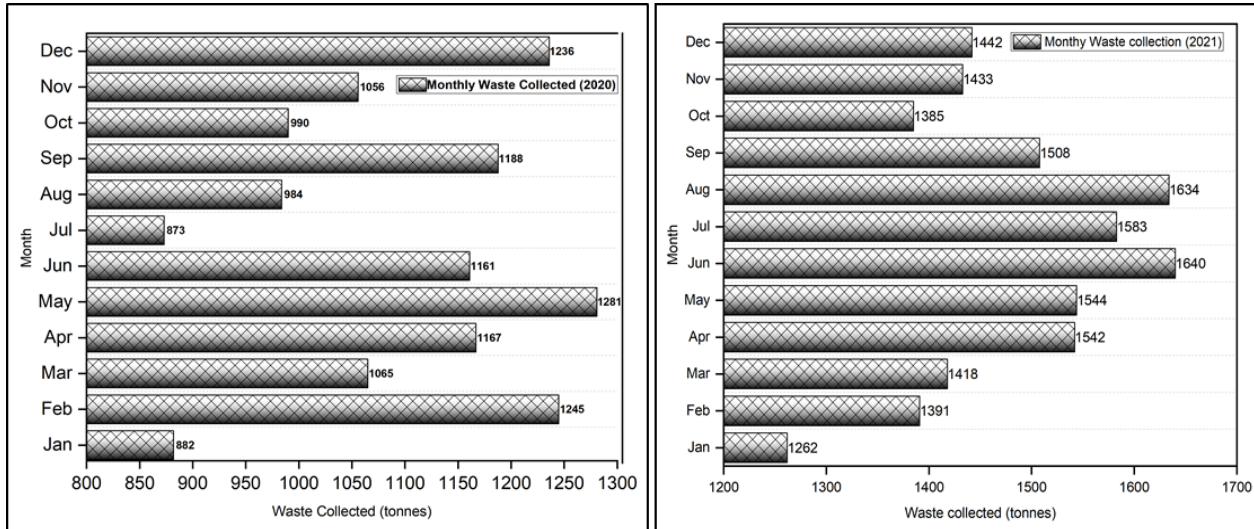


Fig. 3. Total waste collection (a) January to December 2020 and (b) January to December 2021

0.43 kg per capita per day whereas, in Gilgit city, it was 0.16 kg/day during 2016-17 reported by Ali *et al.* [3]. In the municipal area, approximately 20 tonnes of solid waste including organic and inorganic waste were being generated per day from residential areas (Table 2). Every month, the waste collected by GBWMC was approximately 600 tonnes from households while the annual collected waste was approximately 7200 tonnes. The total waste generated per day in commercial areas was approximately 30 tonnes and the waste generation growth rate was approximately 2.28 % annually. These results are in line with the findings of Ali *et al.* [3] that the daily collected waste from commercial and residential areas were 31.5 and 11 tonnes respectively. According to the GBWMC [17], the budget required to collect a tonne of waste is approximately 2976.6 rupees so the total amount required to collect waste in the municipal area of Skardu is approximately 148830 rupees/day.

Table 2. Daily waste generation in the study area.

Parameters	Total/day (Tonnes)
Total solid waste from a commercial area	30
Total solid waste from a household	20
Total solid waste from Skardu Municipal	50

4. CONCLUSION & RECOMMENDATIONS

SWM is a challenging task for GBWMC due to insufficient budget and human resources, lack

of awareness among the masses, and ineffective policies. The ratio of waste generation in Skardu is increasing day by day thus its sustainable management is needed urgently. The local government and Non-government organizations (NGOs) should pay attention to providing proper strategies to resolve this major issue. It is necessary to develop a mechanism to remove SWs from non-designated spots and must define a proper strategy to collect waste from residential and domestic areas and should opt for an eco-friendly disposal system like incineration and landfills.

Based on this study the company needs to plan to combat the impending challenges related to waste materials. The following recommendations and suggestions are set forth for the organizations to be seriously considered and taken into account in the future. The organization requires arranging a maximum awareness campaign in all the districts as well as also needs to cooperate with the local government in designing the map of the city for waste and municipal garbage and sewage activities. In addition, it is suggested to work on advancing the source of income of the organization through local and national markets and organizations to minimize the financial burden of the organization. Furthermore, the organization requires to work on a plan to protect natural resources such as water, green landscapes, lakes, and the Indus River from obnoxious waste.

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6. CONFLICT OF INTEREST

There is no conflict of interest among the authors.

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